AF/2623

Docket No.: 49959-01

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

In re Application of	:	Customer Number: 20277
Ariel BEN-PORATH, et al.	:	Confirmation Number: 5838
Application No.: 09/111,454	:	Tech Center Art Unit: 2623
Filed: July 08, 1998	:	Examiner: V. Bali

For: AUTOMATIC DEFECT CLASSIFICATION WITH INVARIANT CORE CLASSES

TRANSMITTAL OF APPEAL BRIEF

Mail Stop Appeal Brief
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

Submitted herewith in triplicate is Appellant(s) Appeal Brief in support of the Notice of Appeal filed November 24, 2004 . Please charge the Appeal Brief fee of $500 to Deposit Account 500417.

Respectfully submitted,

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APPEAL BRIEF

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Sir:

This Appeal Brief is submitted in support of the Notice of Appeal filed November 24, 2004.

I. REAL PARTY IN INTEREST

The real Party In Interest is Applied Materials, Inc.

II. RELATED APPEALS AND INTERFERENCES

Appellants are unaware of any related appeals and interferences.

III. STATUS OF CLAIMS

Claims 1-3, 6-20, 23-38, and 40-60 are pending in the application. Claims 9-17, 26-34 and 49-60 have been withdrawn from consideration. It is from the rejection of claims 1-3, 6-8, 18-20, 23-25, 35-38, and 40-48 that this Appeal is taken.

IV. STATUS OF AMENDMENTS

There are no outstanding amendments.

V. SUMMARY OF INVENTION

The thrust of the present invention is directed to a method and apparatus for automatically classifying a defect on the surface of a semiconductor wafer into one of a plurality of invariant (i.e., standardized) core classes after inspection with, for example, a scanning electron microscope (SEM) and/or an optical inspection tool (see Application page 6, line 27 to page 7, line 2). The invariant core classes of defects can include a missing pattern on the surface, an extra pattern on the surface, a deformed pattern on the surface, a particle on the surface, a particle embedded in the surface, a particle and a deformed pattern on the surface, or craters and microscratches on the surface (page 7, lines 6-12). The defect may be further classified into one or more subclasses of one of the invariant core classes, the subclasses being of arbitrarily defined defects defined by the user (page 7, lines 2-4). As the defects are classified, counts are maintained of the number of occurrences of each type of defect, and an alarm is raised if the defect count in a particular class exceeds a predetermined level (page 8, lines 11-13).

Defects are accurately and reliably classified and monitored using the present apparatus and methodology, thereby enabling early detection and cure of processing problems (page 8, lines

13-15). All defects are classified by the present methodology into one of a predetermined number of invariant core classes (page 6, line 27 to page 7, line 2). The present invention thereby provides a standardized set of defect classes, which are readily correlated to the causes of defects (page 6, lines 23-26). Moreover, since the defect classes are standardized rather than user-specific, the present apparatus and methodology requires a lesser number of defect images to be obtained for each defect class prior to becoming operational (page 22, lines 1-10). Consequently, the present invention can be easily utilized during start-up and ramp-up of a production line (page 22, lines 10-12).

VI. ISSUES

A. Whether claims 1-3, 6-8, 18-20, 23-25, 37, 38, and 40-42 are unpatentable under 35 U.S.C. §103(a) over U.S. Patent 6,047,083 (Mizuno) in view of U.S. Patent 5,814,829 (Broude) and further in view of U.S. Patent 4,849,901 (Shimizu).

B. Whether claims 35, 36 and 43-45 are unpatentable under 35 U.S.C. § 103(a) over Mizuno, Broude and Shimizu and further in view of U.S. Patent 5,591,971 (Shahar).

C. Whether claim 46 is unpatentable under 35 U.S.C. § 103(a) over Mizuno in view of Shahar.

D. Whether claim 47 is unpatentable under 35 U.S.C. § 103(a) over Mizuno in view of Shahar and further in view of U.S. Patent 5,801,965 (Tagaki).

E. Whether claim 48 is unpatentable under 35 U.S.C. § 103(a) over Mizuno and Shahar and further in view of U.S. Patent 5,960,106 (Tsuchiya).

VII. GROUPING OF CLAIMS

The appealed claims 1, 2, 3, 6, 7, 8, 18-20, 23, 24, 25, 37, 38, 40, 41, and 42 stand or fall together. The appealed claims 35, 36, and 43-45 stand or fall together. The appealed claims 46 and 47 stand or fall together. The appealed claim 48 stands or falls separately.

VIII. THE ARGUMENT

A. The Applied Prior Art

1. Mizuno

The Mizuno reference relates to a semiconductor device defect classification system for determining a probability of defects being or becoming defects causing failure of the device. Such defects are referred to in the art as "killer defects". After classifying defects, Mizuno's methodology determines the percentage chance of failure of the inspected device for each defect, then calculates the probability of failure for the device using weight coefficients. The procedure further includes mapping probable failing devices on a wafer map. By identifying killer defects, Mizuno claims to decrease defects affecting the product yield, and thereby improve the product yield. Absent is the claimed teaching of determining a total number of defects in each class and generating an alarm signal when the number of defects in one class is equal to or exceeds a predetermined number.

2. Broude

Broude relates to a photolithographic mask (or "reticle") inspection system wherein when a threshold number of reticle defects of a particular size at a particular location is exceeded, the

inspection is interrupted and the operator informed, so that time is not wasted continuing inspection of a low-quality reticle. Absent is the claimed teaching of classifying defects into invariant core classes.

3. Shimizu

Shimizu relates to an apparatus for inspecting a substrate for flatness. Shimizu teaches sounding an alarm and notifying the operator if the number of chips having poor flatness exceeds a predetermined number. Absent is the claimed teaching of classifying defects into invariant core classes.

4. Shahar

Shahar relates to an SEM inspection system having multiple electron detectors. Absent is the claimed teaching of classifying defects into invariant core classes.

5. Tagaki

The Tagaki reference relates to a method and apparatus for inspecting a product for defects and classifying the defects. In Tagaki, defect classes are changeable (i.e., the number of classes are expandable) depending on how the defects fit into a constantly evolving classification model. If a defect falls outside or in between "clusters" in the classification space of Tagaki's classification model, a new cluster is made, and/or the operator is asked to classify the defect. Absent is the claimed teaching of classifying defects into invariant core classes.

6. Tsuchiya

Tsuchiya relates to a method and apparatus for inspecting patterns formed on glass. Absent is the claimed teaching of classifying defects into invariant core classes.

B. The Issues Addressed

1. The Examiner Did Not Establish a ***Prima Facie*** Case of Obviousness Under 35 U.S.C. § 103.

The initial burden of establishing a ***prima facie*** basis to deny patentability to a claimed invention under any statutory provision always rests upon the Examiner. ***In re Mayne***, 104 F.3d 1339, 41 USPQ2d 1451 (Fed.Cir. 1997); ***In re Deuel***, 51 F.3d 1552, 34 USPQ2d 1210 (Fed.Cir. 1995); ***In re Bell***, 991 F.2d 781, 26 USPQ2d 1529 (Fed.Cir. 1993; ***In re Oetiker***, 977 F.2d 1443, 24 USPQ2d 1443 (Fed.Cir. 1992). In rejecting a claim under 35 U.S.C. § 103, the Examiner is required to provide a factual basis to support the obviousness conclusion. ***In re Warner***, 379 F.2d 1011, 154 USPQ 173 (CCPA 1967); ***In re Lunsford***, 357 F.2d 385, 148 USPQ 721 (CCPA 1966); ***In re Freed***, 425 F.2d 785, 165 USPQ 570 (CCPA 1970). The Examiner is required to show that all the claim limitations are taught or suggested by the references. ***In re Royka***, 490 F.2d 981, 180 USPQ 580 (CCPA 1974); ***In re Wilson***, 424 F.2d 1382, 165 USPQ 494 (CCPA 1970). In addition, the Examiner is obliged to explain how and why one having ordinary skill in the art would have been realistically motivated to combine the applied references to arrive at the claimed invention. ***In re Ochiai***, 71 F.3d 565, 37 USPQ2d 1127 (Fed.Cir 1991); ***In re Deuel***, ***supra***. In establishing the requisite motivation, it has been consistently held that the Examiner must show an objective teaching in the art that would have motivated one skilled in the art to modify the cited reference to yield the claimed invention. ***In re Jones***, 958 F.2d 347, 21 USPQ2d 1941 (Fed.Cir. 1992); ***In re Mills***, 16 USPQ2d 1430 (Fed.Cir. 1990); ***In re Fine***, 837 F.2d 1071, 5 USPQ2d 1596 (Fed.Cir. 1988).

a. Claims 1-3, 6-8, 18-20, 23-25, 37, 38, and 40-42 are not rendered obvious under 35 U.S.C. §103(a) by Mizuno in view of Broude and Shimizu, because the Examiner has not shown an objective teaching that would have motivated a skilled artisan to combine the references to yield the inventions of these claims.

Regarding the obviousness rejection of independent claims 1, 18, and 37 based on Mizuno, Broude and Shimizu, it would not have been obvious to combine Mizuno and Broude as the Examiner suggests. The Examiner contends that it would have been obvious to modify Mizuno's defect inspection and classification technique by introducing Broude's teaching of counting defects and generating a signal when a threshold number of defects of a particular size and/or at a particular location are found, to thereby yield the invention of claims 1, 18 and 37.

Appellants disagree, and submit that the Examiner has not provided an objective teaching that would have motivated a skilled artisan to incorporate Broude's teaching into Mizuno's system, because none exists. The goal of Mizuno's system is very different from that of Broude, and would not benefit from adding Broude's defect counting and signal-generating functions. Conversely, Broude's system would not gain improved functionality by incorporating Mizuno's teachings.

The purpose of Mizuno's semiconductor device defect classification system is to determine a probability of defects being or becoming killer defects. After classifying defects, Mizuno's methodology determines the percentage chance of failure (called the "degree of criticalness") of the inspected device for each defect, then calculates the probability of failure for the device using weight coefficients. The procedure further includes mapping probable failing devices on a wafer map. This technique is explained in Mizuno at, for example, col. 7, line 45 to

col. 8, line 15. By identifying killer defects, Mizuno claims to decrease defects affecting the product yield, and thereby improve the product yield.

Broude relates to a photolithographic mask (or "reticle") inspection system wherein when a threshold number of reticle defects of a particular size at a particular location is exceeded, the inspection is interrupted and the operator informed, so that time is not wasted continuing inspection of a low-quality reticle (see, e.g., col. 5, lines 47-67). Broude's system is for efficiently discovering and rejecting reticles that do not meet predetermined quality standards.

Mizuno's purposes would not be furthered by Broude's defect counting and signaling technique. Broude's approach to inspection is much different than Mizuno's, and is used in a different context. Broude's technique is for inspecting completed masks before they are used in production to weed out low-quality masks; in other words, a "go -no go" test. In contrast, Mizuno predicts product yield during production by using defect feature data from the inspection process to improve its inspection process and yield, by correlating defect feature data with the chance of such defect features causing failure. None of these functions are performed by Broude's inspection methodology, and none of Mizuno's goals would be served by modifying it with Broude's defect counting and display/inspection shutdown technique. Moreover, there is no objective teaching in Mizuno's yield prediction methodology relating to Broude's functions of defect counting resulting in inspection shutdown, or vice versa. Therefore, a skilled artisan would not have been motivated to add Broude's defect counting and display/inspection shutdown technique to Mizuno's inspection system to yield the invention of independent claims 1, 18 and 37.

As pointed out at page 5 of the May 24, 2004 Final Office Action, to establish obviousness, the Examiner must provide an objective teaching in the art that would have

motivated a skilled artisan to combine or modify the references to yield the claimed invention. It is contended by the Examiner that a skilled artisan would have been motivated to incorporate Broude's counting and display/shutdown features into Mizuno's inspection system to generate a signal to stop the process to get a better yield (see Final Office Action, paragraph bridging pages 6-7). However, there is no support in either reference for this contention. *See, **In re Lee***, 277 F.3d 1338, 1342-44 (Fed.Cir. 2002)(discussing the importance of relying on objective evidence and making specific factual findings with respect to the motivation to combine references).

As discussed above, Broude teaches counting defects, displaying the results and shutting down the inspection process to reject a low-quality reticle, not to improve or predict the yield of the reticle manufacturing process (or of any other manufacturing process). Broude's process is not used for in-process inspection, where yield is an issue, but rather is used after completion of a reticle and before production using the reticle begins.

Moreover, stopping or slowing down the process to improve yield is not taught or even suggested as a desirable action in Mizuno. Mizuno arguably teaches away from such action by teaching the use of its inspection results to determine the severity of defects, thereby improving failure prediction and enabling yield improvements. Mizuno's production line does not need to be slowed or stopped, as suggested by the Examiner, since Mizuno teaches an alternative technique for dealing with defective products; i.e., accurate identification of potentially defective devices. Such action would defeat the purpose of Mizuno's automated inspection/classification/killer defect identification system. It is well-established that if a proposed modification would render the prior art invention being modified unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification.

In re Gordon, 733 F.2d 900 (Fed.Cir. 1984); ***In re Ratti***, 270 F.2d 810 (CCPA 1959)(If a proposed modification or combination would change the principle of operation of the prior art invention being modified, then the teachings of the references are not sufficient to render the claims prima facie obvious). *See also*, **MPEP** § 2143.01.

The Examiner further contends that a conclusion of obviousness should take into account only knowledge which was within the level of ordinary skill at the time the claimed invention was made, and should not include knowledge gleaned only from the applicant's disclosure. However, the motivation to combine the cited references offered in the Final Office Action (i.e., to stop the process to get a better yield) is found *only* in the disclosure of the present application. As discussed immediately above, neither Mizuno nor Broude teach or suggest this. Furthermore, the tertiary Shimizu reference does not furnish any such objective teaching either. Indeed, it is not even alleged by the Examiner that Shimizu furnishes such a teaching. The prior art does not suggest the desirability of the claimed invention. Thus, the Examiner is employing improper hindsight here, using Appellants' disclosure of their motivation for making the invention against them.

The statement in the Final Office Action offered to show motivation to combine Mizuno and Broude with Shimizu to yield the claimed invention is therefore speculative, and cannot support a rejection under 35 U.S.C. § 103.

Consequently, independent claims 1, 18 and 37 are patentable, as are claims 2, 3, 6, 7, 8, 18-20, 23-25, 37, 38 and 40-42, which depend from claims 1, 18 and 37.

b. Claims 35, 36 and 43-45 are not rendered obvious under 35 U.S.C. §103(a) by Mizuno in view of Broude, Shimizu and Shahar, because the Examiner has not shown an objective

teaching that would have motivated a skilled artisan to combine the references to yield the inventions of these claims.

Regarding the obviousness rejection of dependent claims 35, 36 and 43-45 based on Mizuno, Broude, Shimizu and Shahar, the Shahar reference does not furnish the necessary motivation to combine Mizuno, Broude and Shimizu to yield the computer readable medium of independent claim 18, from which claims 35 and 36 depend, or the apparatus of independent claim 37, from which claims 43-45 depend.

Consequently, claims 35, 36 and 43-45 are patentable.

c. Claim 46 is not rendered obvious under 35 U.S.C. §103(a) by Mizuno in view of Shahar, because the Examiner has not shown that all the limitations of this claim is taught or suggested by the references.

Regarding the rejection of independent claim 46 based on Mizuno and Shahar, neither cited reference teaches or suggests the important step of imaging with both an SEM and an optical imager. The Examiner admits that Mizuno does not disclose the claimed combination of SEM and optical imaging. Shahar teaches SEM imaging only. Appellants note that Shahar's detectors 240, 250 are explicitly described as Everton Thorenly detectors (see Shahar col. 5:15-21), which are well-known in the art as electron detectors, not optical detectors as the Examiner contends. The contention, at page 7 of the Final Office Action, that electrons are the emitted light that is sensed by sensors 240, 250, flies in the face of the plain meanings of the terms "optical" and "SEM" as used in this art by equating them to each other, and is therefore improper. One skilled in the art would most certainly appreciate that there is a difference between optical imaging and SEM imaging, and would further appreciate that the Everton

Thorenly detectors 240, 250 that are parts of the SEM of Shahar, are not optical sensors. Since neither reference teaches or suggests the above-discussed SEM/optical imaging step of claim 46, any combination of Mizuno and Shahar, however made, would still be missing this step. Moreover, it would not have been obvious to add this step to any Mizuno/Shahar combination. There is no objective teaching offered by the Examiner to support their contention that a skilled artisan would have been motivated to modify Mizuno's apparatus to obtain a better perspective of the image. This contention is speculative and cannot support an obviousness rejection.

Consequently, claim 46 is patentable.

d. Claim 47 is not rendered obvious under 35 U.S.C. §103(a) by Mizuno in view of Shahar and Tagaki, because the Examiner has not shown that all the limitations of this claim is taught or suggested by the references.

Regarding the obviousness rejection of dependent claim 47 based on Mizuno, Shahar and Takagi, the Takagi refererence does not furnish a teaching or suggestion of the SEM/optical imaging step of claim 46, from which claim 47 depends, missing from Mizuno and Shahar. Therefore, any combination of Mizuno, Shahar and Takagi, however made, would still be missing this step, and it would not have been obvious to add this step to any Mizuno/Shahar/Takagi combination.

Consequently, claim 47 is patentable.

e. Claim 48 is not rendered obvious under 35 U.S.C. §103(a) by Mizuno in view of Shahar and Tsuchiya, because the Examiner has not shown that all the limitations of its base claim are taught or suggested by the references.

Regarding the obviousness rejection of dependent claim 48 based on Mizuno, Shahar and Tsuchiya, the Tsuchiya reference does not furnish a teaching or suggestion of the important step

of imaging with both an SEM and an optical imager of independent claim 46, from which claim 48 depends, missing from Mizuno and Shahar. Thus, any combination of Mizuno, Shahar and Tsuchiya, however made, would still be missing this step, and it would not have been obvious to add this step to any Mizuno/Shahar/Tsuchiya combination.

Consequently, claim 48 is patentable.

IX. SUMMARY

The Examiner's rejections under 35 U.S.C. § 103 do not withstand scrutiny, in that the Examiner has not shown that all the claim limitations are taught or suggested by the references, and has not shown an objective teaching in the art that would have motivated a skilled artisan to combine the cited references to yield the claimed inventions. Appellants, therefore, respectfully submit that the Examiner has not established a prima facie basis to deny patentability to the claimed invention under 35 U.S.C. § 103.

X. PRAYER FOR RELIEF

In view of the foregoing arguments, Appellants respectfully solicit the Honorable Board to reverse the Examiner's rejection of claims 1-3, 6-8, 18-20, 23-25, 35-38, and 40-48 under 35 U.S.C. § 103.

To the extent necessary, a petition for an extension of time under 37 CFR 1.136 is hereby made. Please charge any shortage in fees due in connection with the filing of this paper,

including extension of time fees, to Deposit Account 12-2237 and please credit any excess fees to such deposit account.

Respectfully submitted,

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APPENDIX 1

1. A method of automatically classifying defects on the surface of an article, which method comprises at least:

imaging the surface;

classifing each of the defects as being in one of a predetermined number of invariant core classes of defects;

determining a total number of defects in each of the core classes; and

generating an alarm signal when the total number of defects in a specific one of the core classes is equal to or greater than a first predetermined number.

2. The method according to claim 1, wherein the core classes of defects comprise a missing pattern on the surface, an extra pattern on the surface, a particle on the surface, a particle embedded in the surface, and microscratches on the surface.

3. The method according to claim 1, comprising imaging the surface with a scanning electron microscope.

6. The method according to claim 1, comprising further classifying one of the defects as being in one of an arbitrary number of variant subclasses of at least one of the invariant core classes.

7. The method according to claim 6, comprising

classifying a plurality of defects on the surface of the article; and

determining a total number of defects in each of the subclasses.

8. The method according to claim 7, comprising generating an alarm signal when the total number of defects in a specific one of the subclasses is about equal to or greater than a second predetermined number.

18. A computer-readable medium bearing instructions for automatically classifying defects on the surface of an article, said instructions, when executed, being arranged to cause one or more processors to perform the steps of:

imaging the surface;

classifying each of the defects as being in one of a predetermined number of invariant core classes of defects;

determining a total number of defects in each of the core classes; and

generating an alarm signal when the total number of defects in a specific one of the core classes is about equal to or greater than a first predetermined number

19. The computer-readable medium according to claim 18, wherein the core classes of defects comprise a missing pattern on the surface, an extra pattern on the surface, and a particle on the surface.

20. The computer-readable medium according to claim 18, wherein the instructions, when executed, are arranged to cause the one or more processors to perform the step of imaging the surface with a scanning electron microscope.

23. The computer-readable medium according to claim 18, wherein the instructions, when executed, are arranged to cause the one or more processors to perform the step of classifying one of the defects as being in one of an arbitrary number of subclasses of at least one of the invariant core classes, the subclasses being of arbitrarily defined defects.

24. The computer-readable medium according to claim 23, wherein the instructions, when executed, are arranged to cause the one or more processors to perform the steps of:

classifying a plurality of defects on the surface of the article; and

determining a total number of defects in each of the subclasses.

25. The computer-readable medium according to claim 24, wherein the instructions, when executed, are arranged to cause the one or more processors to perform the step of generating an alarm signal when the total number of defects in a specific one of the subclasses is about equal to or greater than a second predetermined number.

35. The computer-readable medium according to claim 18, wherein the instructions, when executed, are arranged to cause the one or more processors to perform the step of imaging by acquiring a plurality of images using a plurality of spaced-apart detectors.

36. The computer-readable medium according to claim 35, wherein the instructions, when executed, are arranged to cause the one or more processors to acquire the images by causing the detectors to collect electrons.

37. An apparatus for classifying defects on the surface of an article, comprising:

an imager to produce an image of the defect and a reference image;

a storage device to store the defect image and the reference image;

a comparator to compare the defect image and the reference image;

a processor to classify the defect as being in one of a predetermined number of invariant core classes of defects;

a first counter for counting the number of defects in each of the core classes; and

a first signal generator for generating an alarm signal when the total number of defects in a specific one of the core classes is about equal to or greater than a first predetermined number.

38. The apparatus of claim 37, wherein the imager is a scanning electron microscope (SEM).

40. The apparatus of claims 37, wherein the storage device is a digital storage device.

41. The apparatus of claim 37, further comprising of processor for classifying the defect as being in one of arbitrary number of subclasses of at least one of the invariant core classes, the subclasses being of arbitrarily defined defects.

42. The apparatus of claim 41, further comprising a second counter for counting the number of defects in each of the subclasses and a second signal generator for generating an alarm signal when the total number of defects in a specific one of the subclasses is about equal to or greater than a second predetermined number.

43. The apparatus of claim 38, further comprising a plurality of spaced-apart detectors and a monitor to display images produced by the plurality of detectors.

44. The apparatus of claim 38, wherein the SEM comprises an SEM column, wherein a first one of the plurality of detectors is disposed inside the SEM column and a second one of the plurality of detectors is disposed outside the SEM column.

45. The apparatus of claim 44, further comprising a first monitor for displaying an image produced by the first detector, and a second monitor for displaying an image produced by the second detector.

46. A method of automatically classifying a defect on the surface of an article; which method comprises:

imaging the surface with a scanning electron microscope and an optical imager; and

classifying the defect as being in one of a predetermined number of invariant core classes of defects.

47. The method according to claim 46, wherein the classes of defects include the color of the surface.

48. The method according to claim 46, wherein the surface is glass, and the classes of defects include a particle embedded in the surface and substantially not protruding from the surface.